CLUSTERING METHOD FOR BONE TISSUE CLASSIFICATION USING ACOUSTIC EMISSION TECHNIQUE

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ABSTRACT

Bone is one of the important parts of human, as main part of the body it will support the vital internal organs of man and it is also used to move or walk. There are two types of bone structure in the human body that is compact bone and soft bone. Compact bone is located at the top of the bone structure, it is hard and compact. While the soft bone is in bone structure, compact bone below it softer and less dense than compact bone above. This project was undertaken to identify the location of compact bone or soft bone during perforation process underway. With the advent of my study, it can be used as a reference to identify the position of medical officer to penetrate the sides of which are correct or not based the graph. That RMS versus kurtosis, the conclusion if the perforations run and AE signals received from the same or they are in the group of points of reference against kurtosis RMS graph therefore safe position from the position of the spinal cord penetrate.

ABSTRAK

Tulang merupakan salahsatu bahagian manusia yang penting, ianya sebagai bahagian sokongan bagi sokongan bagi organ-organ dalaman penting manusia dan ianya juga digunakan untuk bergerak atau berjalan. Terdapat dua jenis struktur tulang didalam badan manusia iaitu tulang padat dan tulang lembut. Tulang yang padat berada dibahagian atas struktur tulang,ianya keras dan padat. Manakala tulang lembut berada didalam struktur tulang,dibawah tulang padat, ianya lebih lembut dan kurang padat berbanding dengan tulang padat tadi. Projek ini dijalankan untuk mengenalpasti kedudukan tulang padat ataupun tulang lembut ketika proses penebukan dijalankan. Dengan adanya kajian saya ini, ia dapat digunakan sebagai rujukan kepada pegawai perubatan untuk mengenalpasti kedudukan tebukan itu berada diposisi yang betul atau tidak berdasarkan rujukan graf kajian yang saya lakukan. Iaitu RMS melawan kurtosis, kesimpulannya jika proses penebukan dijalankan dan isyarat yang diterima dari AE sama atau ianya berada didalam kawasan kelompok titik dari rujukan graf RMS melawan kurtosis makanya kedudukan posisinya selamat dari tertebuk saraf tunjang

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LIST OF SYMBOLS

E	Value Of The Quantity Of Time
k	Kurtosis
M	Number Of Data
x	Data
y	Root Mean Square
μ	Data input
σ	Standard Derivation

LIST OF ABBREVIATIONS

AE	Acoustic Emission
AET	Acoustic Emission Testing
C1-C7	C for Cervical shape
L1-L5	L for Lumbar
NDT	Non-Destructive Testing
PSD	Power Spectral Density
RMS	Root Mean Square
T1-T12	T for Thoracic

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CHAPTER 1

INTRODUCTION

1.1 PROJECT BACKGROUND

This project is basically focusing on new invention for medical and engineering purpose as well. Based on my project “Clustering method for bone tissue classification using acoustic emission technique”, it is improvising the old method of classification the bone tissue. Acoustic emission technique is the latest technology tool for classification bone tissue failure loads of the spine is used to develop tolerance data and in turn there is used to develop injury prevention devices. Acoustic emission (AE) sensor could provide more objective data on the timing of injury as they record dynamic stress waves generated by the release of energy in a material, such as the initiation of a fracture and they have been used to identify the time of injury of skull, ankle and tibia bones. Frequency signal from AE data has led to the identification of failure mechanisms of composite material. So, through this tool the classification of the bone tissue will be fast and more precise.

1.2 THE OBJECTIVE OF THE PROJECT

The objective of this project is to clustering the type of bone tissue other it is a sponge or the compact by using the pedicle screw technique in the back bone. It is very vital for this project to understand the frequency from energy inside the bone from the sensor of the acoustic emissions. Review the data get from signal of acoustic emission and analyse the accurate data without have noise or error.

1.3 SCOPE OF PROJECT

This scope is more important to ensure the research is done by the right method. In this research, it will focus of the acoustic emissions technique to monitor the pedicle screw fixation procedure. In this procedure, the signal from the hole at the bone that was come up from the internal bone energy because of the fraction between the probe and bone or other.

This project using the acoustic emission technique method only to solve the problem in the bone. Using the matlab software to make a cluster in the suitable type of clustering

1.4 PROBLEM STATEMENT

The problem in medical is pedicle screw technique nowadays is using the human sense to penetrate the human bone by professional doctor to solve the problem in human vertebra. By using the human sense method the percentage to fail still occur and will cause the death or handicap due to the pedicle screw will be penetrate to the spinal cord.

CHAPTER 2

LITERATURE REVIEW

In this thesis, have 3 elements have relative to make the experiment will success andachieve the objective. It is major element it is about human vertebral column, pedicle screw fixation, pedicle screw fixation and the clustering method using matlab software.

2.1 BONE

Bone is very important for human body because to support the framework that hold the body.It also provide a protective cavity for the brain (skull), cord (vertebrae) and vital (rib cage).Human use the bone to movement in provide attachment points for skeletal muscles and are used as levers. Human anatomy has divides bones into two major group, it is long bones and flat bones. This classification based solely on the gross appearance of the type of bone. The long bone category was extended to include two further types of bone that neither flat nor long, short and irregular bones. About the flat bone is sternum bone, ribs, scapulae and cranium. (Summerlee, 2008)

The bone tissue was divided into two types. First is compact or lamellar bone is dense with a few spaces or cavities and is composed of structural units called osteons or haversian system. The osteons like have ring of matrix call lamella which contain collagen fibers. The center is a haversian canal containing small blood vessels and nerve fibers. Then is sponge or cancellous bone lacks haversian system and has numerous space and cavities. That consists of an irregular lattice or network of thin, flat plate of bone call trabeculae. (Harris et al., 2003)

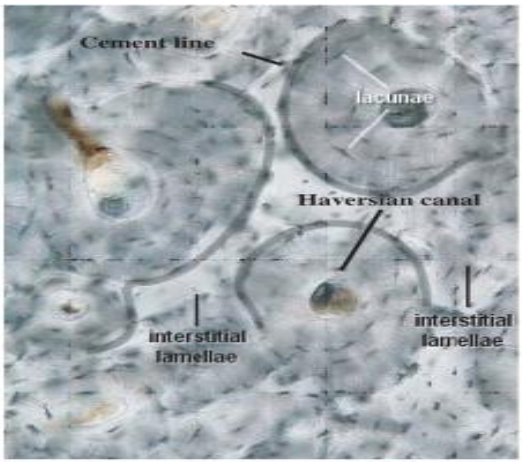

Figure 2.1: Compact bone

Source: Nather et al.,2002

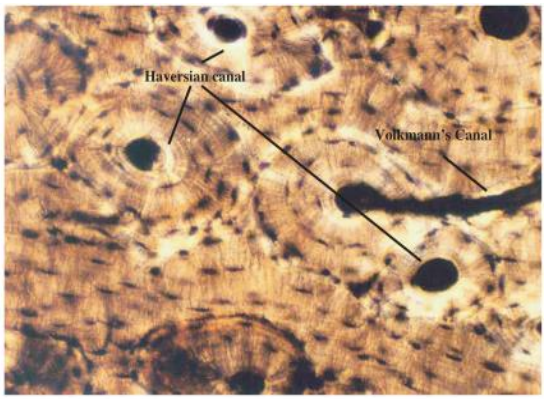

Figure 2.2: Sponge bone

Source: Nather et al., 2002

2.2 BASIC HUMAN VERTEBRAL COLUMN ANATOMY

2.2.1 Briefing Introduction Of Human Vertebral Column

In the human body has a lot of bones to support and protected the organs in the body, it provided a lot of shape and name. The bone also has a storage the site the mineral and provides the medium-marrow for the development and storage of blood cells. The basic concept is the bone have related in dense type of connective tissue impregnated with salt,

the salt of calcium such as calcium phosphate, calcium carbonate and other. The bone is a dense type of connective tissue by inorganic is compact tissue, cancellous tissue and the last subchondral tissue is the smooth at the ends of and it has covered with another type of tissue call cartilage. Compact and cancellous tissues are called the periosteum. Beneath the hard outer shell of the periosteum there are tunnels and canals through which blood and lymphatic vessels run to carry nourishment for the bone. Muscles, ligaments and tendons may attach to the periosteum. (Gray, 2001)

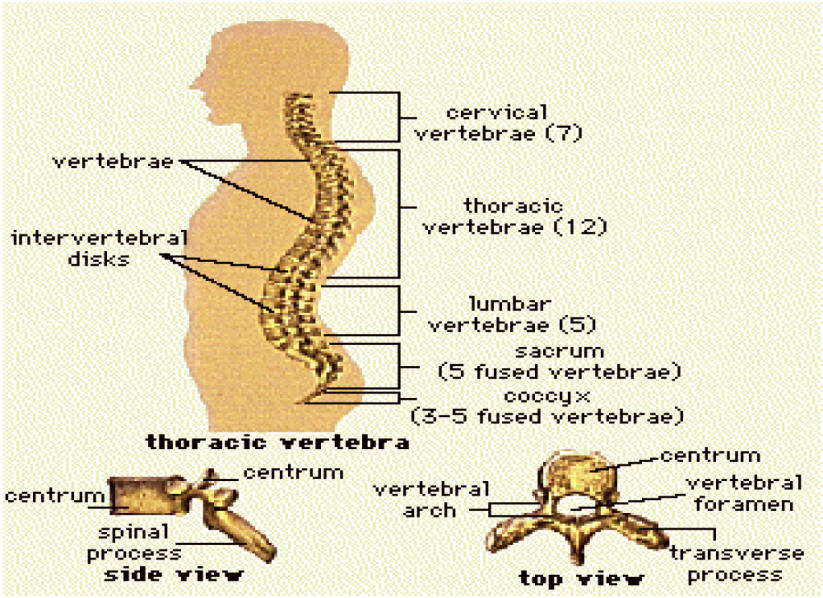

Figure 2.3: Human vertebral column

Source: Thesebonesofmine.wordpress.com

2.2.2 Cervical Vertebrae Spine

Usually the human cervical vertebrae are smallest than the true vertebrae in the thoracic spine (upper back) and the lumbar spine (lower back). It can be readily distinguished from the thoracic or the lumbar regions. The presence of the foramen (hole in the backbone) in the transverse process and also thorough which passes the vertebral artery.

This cervical vertebra is like a ring that rotates around the second vertebral body and this is unique compare the other vertebral.

The spine has 24 spinal bones call vertebrae. Vertebrae position is on top of each other to form the spinal column. At the human body, the spinal column in the upright support to make the human stronger. In the side, three curves from the spine. It called the cervical spine as a neck, curves slightly inward. The middle back in the backside it call thoracic spine, curves outward. The outward curve of the thoracic spine is kyphosis. The low back also called the lumbar spine and curves slightly inward. An inward curve of the spine is called lordosis.

In the vertebrae, doctor was use classes using the C1 to C7 to refer part in the vertebrae. The C1 start from the top of the cervical spine is connects to the bottom of the skull. Then the end of the vertebrae is the C7 is curves slightly inward where join the top of the thoracic spine in the chest area. The based in C1 also call the atlas is the two thickened bone arches form a large hole through the center of the atlas.

The large opening is because of the spinal cord is wider where it first exits in the brain and skull. In this case the atlas also has much wider bone have projections point compared to each side. In the top of the C2 vertebra is called the axis, has a large bony knob on top and also called the dens. Then for the dens points up and fits through a hole in the atlas is a joints of the axis give the neck most of its ability to turn to the left and right. In the cervical vertebra, has main section it is from C2 to C7 is formed by a vertebral body in the round block of the bone. The vertebral body where attaches to the bone ring and this two pedicle bones it was connected directly to the back of the vertebral body. (Burwell et al., 1983)

In between the vertebrae of each spinal segment are have two facet joints. The facet joints are located at the back of the spinal column. There are two facet joints between each pair of vertebrae on the right. The intervertebral disc sits directly in front of the opening. A bulged or herniated disc can narrow the opening and put pressure on the nerve. A facet joint sits in back of the foramen. Bone spurs that form on the facet joint can project into the tunnel, narrowing the hole and pinching the nerve. (Burwell et al., 1983)

The complete ring has two lamina bones joining the pedicles and it forms the outer rim of the bone ring. When the vertebrae are stacked with each other it has gone hollow tube that surrounds the spinal cord. They have provided a protective roof over the spinal cord. At the back of the spinal have two laminar join together and have the projections call spinous processes. The process can be felt as you rub with a finger move in the back of your spine. The spine is the spinous process of C2 is the larger bump near the top and the neck where the cervical and thoracic spines join together it is in C7. (Burwell et al., 1983)

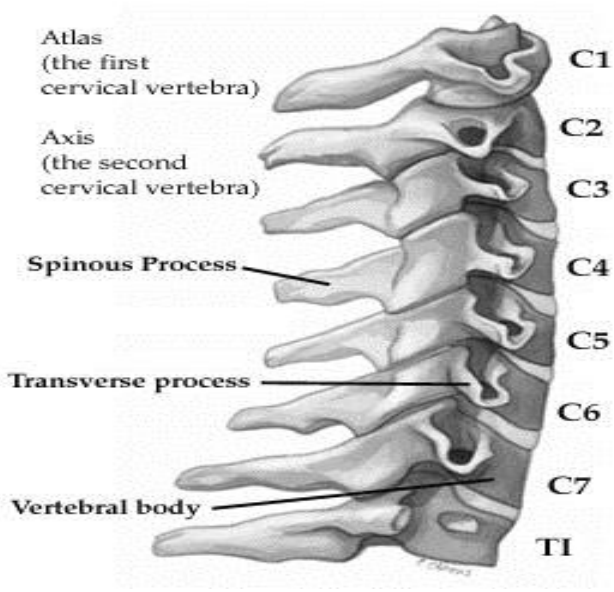

Figure 2.4: Cervical vertebrae spine

Source: Parker et.al., 1999

2.2.3 Thoracic Vertebrae

Thoracic vertebrae are distinct in featuring costal facets on their transverse processes and bodies. Basically a thoracic vertebral body articulates have two costal heads with while the transverse process articulates with the tubercle of one of these ribs with these articulations form the costo vertebral joints. It will increase the anterior posterior and transverse diameters of the thoracic cavity in these joints serve to elevate and depress the

ribs. For posteriorly permitting rotation and some lateral flexion, the thoracic spine is the superior will inferior articular facets face anteriorly. (Oldnall, 2000)

The severely restricts flexion and extension of the thoracic because of the orientation in these facts, as well as the unfairly directed spinous processes it also the costovertebral joints. It different, in the medially and laterally facing articularfacets of the five lumbar vertebrae allow for a great deal of flexion and extension but restrict rotation. (Oldnall, 2000)

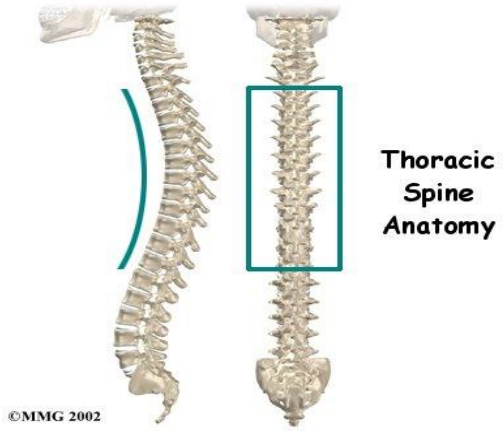

Figure 2.5: Thoracic spine

Source: Patient Educatio-Thoracic Spine, 2002

2.2.4 Lumbar Spine Vertebrae

The lumbar spine is the lower five vertebrae. Doctors class it to these vertebrae as L1 to L5.The L5 part is the lower vertebra is join to the top of the sacrum, the base of the spine that fits between the two pelvic bones like shape triangular. The normal person has five lumbar vertebras but the special person has a sixth lumbar vertebra. This case doesn't usually cause any particular problems of each vertebra is formed by a round block of bone it call a vertebral body.

The taller and the bulkier in the vertebral bodies in lumbar part to compared the rest in the spine. To support the withstand pressure from body weight and from movements such as lifting, carrying and twisting. In the lumbar vertebral also carried the large and powerful muscles attaching or near the lumbar spine place extra force on the lumbar vertebral bodies. (Botwin et al., 2003)

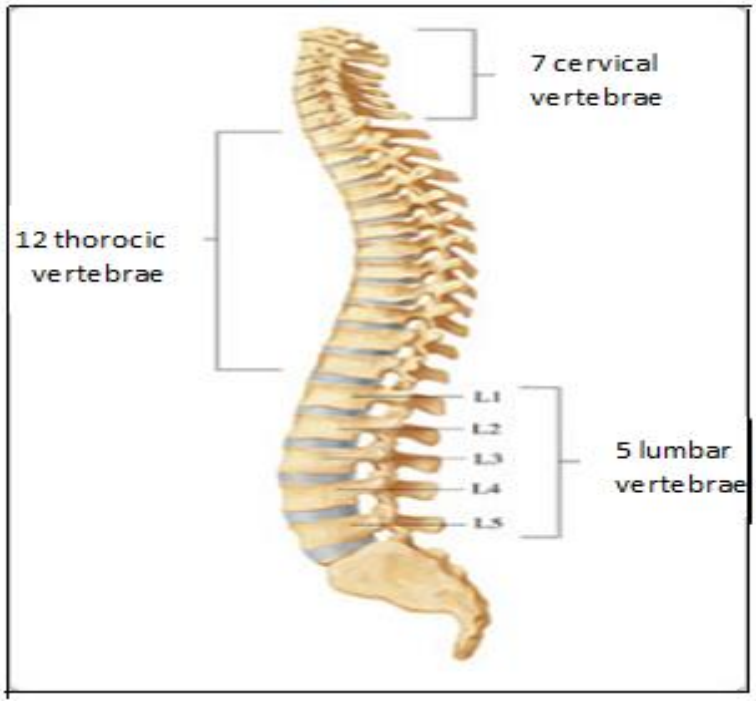

Figure 2.6: Lumbar spine vertebrae

Source: www.nebh.org

2.3 PEDICLE SCREW FIXATION

2.3.1 Briefing History Of Pedicle Screw Fixation

Boucher has been widely credited with the first use of pedicle screws in North America, his report suggests that his innovation was a longer facet screw that occasionally obtained oblique purchase across the pedicle. His screws were not aimed down the long axis of the pedicle. Thus, it seems that Harrington and Tullos deserve credit for the first

deliberate attempt to put pedicle screws through the isthmus of the pedicle. Their report, published in 1969, described the attempted reduction of two cases of high-grade spondylolisthesis.

2.3.2 Briefing About Pedicle Screw Fixation

The anatomy of the human pedicle has been studied exhaustively in different races in children and adults. Patterns of pedicle anatomy unique to the cervical spine the thoracic and the lumbar spine and the sacrum have been clearly identified. Measurements of the outer and inner diameters of the pedicle have been performed extensively. The inner diameter of the pedicle the critical surgical dimension has been shown to be more directly related to the height of the patient than to the gender. However, wide individual variations within common patterns of anatomy are the rule.

This forces the surgeon to understand the individual anatomy of the patient, in order to achieve clinical success and to appreciate the patterns of pedicle anatomy that are common to the human race in general. There do not seem to be more than modest differences in pedicle anatomy from race to race.

The screws are designed to connect with certain fixation devices, most commonly either a plate or a rod. Linkages can be rigid as with plate systems, internal fixators or various rod systems or have a coupling allowing some motion. Some systems also allow for interval pedicle fixation to control or apply either lordotic-kyphotic or rotational forces on the vertebra. The first issue regarding complications based on the large number of instrumentation systems their rapidity of change and limited universal usage relates to instrument mechanical failure. Each has its own strengths and weaknesses and it is important for the user to recognize these facts and to select the appropriate construct for each surgical need and each functional spinal unit pedicle screw. It should be introduced by drilling the path and then applying the screw.

The transverse pedicle diameters range from 4.5 mm at T5 to 18 mm at LS and the sagittal diameter is generally slightly larger than the transverse slant diameter. The angle at which the pedicle emerges from the vertebral body in the transverse plane also varies with

craniocaudal location, being less than 10 inch in the thoracic spine with a slight anterolateral angulation at T12, it progressively increases in the lumbar spine to a maximum of almost 30 inch medial angulation from posterolaterally to anteromedially. (Gaines, 2000)

The pedicles also exhibit varying angles in the sagittal plane. The pedicles are directed approximately 15-17 inch cephalad for the majority of the thoracic spine and neutral (90 inch) for the majority of the lumbar spine with the exception of L5, which angles caudally an average of 18 inch. The distance to the anterior vertebral cortex as measured from the posterior aspect of the pedicle, through the pedicle is approximately 40 to 45 mm in the thoracic spine and 50 mm in the lumbar spine. (James et al., 1992).

2.3.2.1 Prepare screw hole and determine screw length

In this pedicle screw fixation, have use three type of screw to penetrates and determine the deep of the hole. Firstly is the pedicle awl (probe a) to make the penetrates in the compact layer, then went the pedicle inside the sponge layer the pedicle probe (probe b) has to use until the pedicle thru the end of the layer and with pedicle probe also use for enlarge the hole. For determine the length of the pedicle screw (probe c) using the depth gauge for pedicle screw. (Aebi et al., 2007)